

Industrial Hygiene Competency 1.10

Competency 1.10 Industrial hygiene personnel shall demonstrate a working level knowledge of personal protective equipment (PPE) and the programs used to control exposures within acceptable levels.

1. Supporting Knowledge and Skills

- a. Discuss the selection, use, maintenance, limitations, and capabilities of respiratory equipment.
- b. Describe the major elements of the hearing conservation program.
- c. Discuss personnel limitations in the use of personal protective equipment.
- d. Discuss how codes, regulations, standards, and certification procedures affect the use of personal protective equipment.
- e. Discuss matching personal protective equipment to the type of exposure.
- f. Discuss how the properties of absorption, adsorption, and filtration mechanisms (respiratory protection) affect the selection of personal protective equipment.
- g. Discuss matching protective clothing to exposure conditions.
- h. Discuss how to recognize when personal protective equipment is an acceptable and appropriate alternative to other control mechanisms.
- i. Discuss how to recognize when personal protective equipment is a necessary companion to other control measures.

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2. Self-Study Activities (corresponding to the intent of the above competency)

Below are two web sites containing many of the references you may need.

| Web Sites | | |
|-------------------------------|---|--|
| Organization | Site Location | Notes |
| Department of Energy | http://wastenot.inel.gov/cted/stdguido.html | DOE Standards, Guides, and Orders |
| OSHA | http://www.osha-slc.gov/ | OSHA documents and search engine |
| U.S. House of Representatives | http://law.house.gov/cfr.htm | Searchable Code of Federal Regulations |

Read Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; **scan** Subpart I, “Personal Protective Equipment,” of 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*; and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, “General Description and Discussion of the Levels of Protection and Protective Gear.”

EXERCISE 1.10-A What are the two basic objectives of any personal protective equipment (PPE) program?

EXERCISE 1.10-B Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, in the following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

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| Matching Respiratory Protection with Limitation | |
|---|--------------------------------|
| Disadvantages | Type of Respiratory Protection |
| At very cold temperatures, scrubber efficiency may be reduced and CO ₂ breakthrough may occur. | |
| Can only be used against gas and vapor contaminants with adequate warning properties. | |
| Provides only 5 to 15 minutes of respiratory protection. Cannot be used for entry. | |
| Bulky, heavy, and may impair movement in confined spaces. | |
| Air line is vulnerable to damage, chemical contamination, and degradation. | |

EXERCISE 1.10-C Name three physiological factors that may affect worker ability to function using PPE.

Read paragraphs a through c of 29 CFR 1910.95, *Occupational Noise Exposure*.

EXERCISE 1.10-D Referring to 29 CFR 1910.95, what is the criterion (or action level) for which a hearing conservation program is required?

EXERCISE 1.10-E Referring to 29 CFR 1910.95, describe the basic elements of a hearing conservation program.

Read Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*.

EXERCISE 1.10-F Describe the various types and purpose of personal protective equipment (PPE).

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| Types and Purpose of Personal Protective Equipment (PPE) | | |
|--|---|---------|
| Body Part Protected | PPE | Purpose |
| Eye and face | Face shield | |
| | Splash hood | |
| | Safety glasses | |
| | Goggles | |
| | Sweat bands | |
| Respiratory | Self-contained breathing apparatus | |
| | Supplied-air respirators | |
| | Air-purifying respirators | |
| Hands and arms | Gloves and sleeves | |
| Foot | Safety boots | |
| | Disposable shoe or boot covers | |
| Head | Safety helmet | |
| | Hood | |
| | Protective hair covering | |
| Full body | Fully encapsulating suit | |
| | Nonencapsulating suit | |
| | Aprons, leggings, and sleeve protectors | |

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EXERCISE 1.10-G Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

| Levels of Protection Ensembles | | |
|--------------------------------|---|-----------------------|
| Level | Protection Provided | Recommended Equipment |
| A | The highest available level of respiratory, skin, and eye protection. | |
| B | Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified. | |
| C | Same level of skin protection as Level B, but a lower level of respiratory protection. | |
| D | No respiratory protection. Minimal skin protection. | |

Read 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection.

EXERCISE 1.10-H Referring to 29 CFR 1910.120 (g), under what general circumstances would the personal protective equipment (PPE) be used as a control measure to reduce and maintain to or below the permissible exposure limits or dose limits?

Read Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; **scan** Subpart I, "Personal Protective Equipment," of 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*, and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

EXERCISE 1.10-I What is the preferred hierarchy of implementation of the hazardous material controls and why?

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EXERCISE 1.10-J Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

EXERCISE 1.10-K Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, what are the primary and secondary considerations when selecting protective clothing?

EXERCISE 1.10-L When is personal protective equipment a necessary companion to other hazard control measures?

EXERCISE 1.10-M Define absorption, adsorption, and filtration in the context of respiratory protection.

EXERCISE 1.10-N Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* and 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*, match appropriate regulation (third column) and its source (fourth column) with the type of personal protective equipment (first column).

| Type of Protection | Answers | Regulation | Source |
|--------------------|---------|---|---|
| General | | 1. 29 CFR 1910.135 2. 29 CFR 1910.95 3. 29 CFR 1910.134 4. 29 CFR 1910.132 5. 29 CFR 1910.136 6. 29 CFR 1910.133 | a. 41 CFR 50-204.10 b. ANSI Z89.1 c. 41 CFR 50-204.7 d. ANSI Z87.1 e. ANSI Z41.1 f. ANSI Z88.2 |
| Eye and Face | | | |
| Noise Exposure | | | |
| Respiratory | | | |
| Head | | | |
| Foot | | | |

3. Summary

(From *Fundamentals of Industrial Hygiene*, Chapter 17)

The degree of health hazard to an individual arising from exposure to environmental factors or stresses depends on four factors: (1) the nature of the environmental factor or stress, (2) the level of exposure, (3) the duration of exposure, and (4) individual susceptibility. After a list of chemicals and physical agents to which employees are exposed has been prepared, it is necessary to determine which of the environmental factors or stresses may result in hazardous exposures and need further evaluation. Valuable information can be obtained by observing the manner in which health hazards are generated, control measures are used, and by determining the number of people involved. The kind of provisions that must be installed to protect against health hazards will vary from plant to plant, from one toxic material to another, and from process to process.

No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus, PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as underprotection can create hazards and should be avoided.

4. Exercise Solutions

EXERCISE 1.10-A What are the two basic objectives of any personal protective equipment (PPE) program?

ANSWER 1.10-A

1. To protect the wearer from safety and health hazards.
2. To prevent injury to the wearer from incorrect use and/or malfunction.

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EXERCISE 1.10-B Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, in the following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

ANSWER 1.10-B

| Disadvantages | Type of Respiratory Protection |
|---|---|
| At very cold temperatures, scrubber efficiency may be reduced and CO ₂ breakthrough may occur. | Closed-circuit SCBA |
| Can only be used against gas and vapor contaminants with adequate warning properties. | Air-purifying |
| Provides only 5 to 15 minutes of respiratory protection. Cannot be used for entry. | Escape-only SCBA |
| Bulky, heavy, and may impair movement in confined spaces. | Self-contained breathing apparatus |
| Air line is vulnerable to damage, chemical contamination, and degradation. | Positive-pressure supplied-air respirator |

EXERCISE 1.10-C Name three physiological factors that may affect worker ability to function using PPE.

ANSWER 1.10-C Any three of the following:

- Physical condition
- Level of acclimatization
- Age
- Weight

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EXERCISE 1.10-D Referring to 29 CFR 1910.95, what is the criterion (or action level) for which a hearing conservation program is required?

ANSWER 1.10-D Whenever employee noise exposures equal or exceed an eight-hour time weighted average (TWA) sound level of 85 decibels.

EXERCISE 1.10-E Referring to 29 CFR 1910.95, describe the basic elements of a hearing conservation program.

ANSWER 1.10-E

1. Monitoring - a sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program.
2. Employee notification - the employer shall notify each employee exposed at or above an eight-hour time weighted average (TWA) sound level of 85 decibels.
3. Observation of monitoring - the employer shall provide affected employees with an opportunity to observe noise level monitoring.
4. Audiometric testing program - The employer shall make available at no cost to the employee audiometric testing, which is conducted in accordance with specified standards.
5. Hearing protectors - employers shall provide hearing protectors attenuated to the environment in which they will be worn and ensure that the employees wear them.
6. Training program - the employer shall provide annual training to all employees covering the topics of effects of noise on hearing; purpose and use of hearing protectors; and purpose of audiometric testing.
7. Access to information and training materials - employers shall make available to employees and other interested parties the materials used in the training program.
8. Record keeping - the employer shall maintain an accurate record of all employee exposures and audiometric testing.

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EXERCISE 1.10-F Describe the various types and purpose of personal protective equipment (PPE).

ANSWER 1.10-F

| Types and Purpose of Personal Protective Equipment (PPE) | | |
|--|------------------------------------|--|
| Body Part Protected | PPE | Purpose |
| Eye and face | Face shield | Protects against chemical splashes. |
| | Splash hood | Protects against chemical splashes. |
| | Safety glasses | Protect eyes against large particles and projectiles. |
| | Goggles | Can protect against vaporized chemicals, splashes, large particles, and projectiles. |
| | Sweat bands | Prevents sweat-induced eye irritation and vision impairment. |
| Respiratory | Self-contained breathing apparatus | Provides the highest available level of protection against airborne contaminants and oxygen deficiency. |
| | Supplied-air respirators | Protect against most airborne contaminants and permitted for use in oxygen-deficient atmospheres. |
| | Air-purifying respirators | Protect against specific chemicals and particulates and up to specific concentrations. |
| Hands and arms | Gloves and sleeves | Protect hands and arms from chemical contact. |
| Foot | Safety boots | Protect feet from contact with chemicals and from compression, crushing, or puncture by falling, moving, or sharp objects. |
| | Disposable shoe or boot covers | Protect safety shoes or boots from contamination. |

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| Types and Purpose of Personal Protective Equipment (PPE) | | |
|--|---|---|
| Body Part Protected | PPE | Purpose |
| Head | Safety helmet | Protects head from blows. |
| | Hood | Protects against chemical splashes, particulates, and rain. |
| | Protective hair covering | Protects hair against contamination, entanglement in machinery or equipment, or from interfering with vision and with the functioning of respiratory devices. |
| Full body | Fully encapsulating suit | Protects against splashes, dust, gases, and vapors. |
| | Nonencapsulating suit | Protects against splashes, dust, and other materials, but not against gases and vapors. |
| | Aprons, leggings, and sleeve protectors | Provides additional splash protection of chest, forearms, and legs. |

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EXERCISE 1.10-G Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

ANSWER 1.10-G

| Levels of Protection Ensembles | | |
|--------------------------------|--|---|
| Level | Protection Provided | Recommended Equipment |
| A | The highest available level of respiratory, skin, and eye protection. | <ul style="list-style-type: none">• Positive pressure, full face-piece self-contained breathing apparatus, or positive pressure supplied-air respirator with escape SCBA• Totally-encapsulating chemical- protective suit |
| B | Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified. | <ul style="list-style-type: none">• Positive-pressure, full face-piece self-contained breathing apparatus, or positive-pressure supplied-air respirator with escape SCBA• Hooded, chemical-resistant clothing• Gloves• Goggles |
| C | Same level of skin protection as Level B, but a lower level of respiratory protection. | <ul style="list-style-type: none">• Full-face or half-mask air-purifying respirators• Hooded, chemical-resistant clothing |
| D | No respiratory protection. Minimal skin protection. | <ul style="list-style-type: none">• Coveralls• Chemical-resistant, steel toe and shank boots/shoes• Gloves• Goggles |

EXERCISE 1.10-H Referring to 29 CFR 1910.120 (g), under what general circumstances would the personal protective equipment (PPE) be used as a control measure to reduce and maintain to or below the permissible exposure limits or dose limits?

ANSWER 1.10.H Whenever engineering controls and work practices are not feasible or not required.

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EXERCISE 1.10-I What is the preferred hierarchy of implementation of the hazardous material controls and why?

ANSWER 1.10-I Engineering controls first, then administrative, with PPE as the last choice because this approach minimizes human intervention with the hazardous material.

EXERCISE 1.10-J Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

ANSWER 1.10-J (Any reasonable paraphrase of the following:) “Whenever it is necessary by reason of hazards of processes or environment, radiological hazards, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.”

EXERCISE 1.10-K Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, what are the primary and secondary considerations when selecting protective clothing?

ANSWER 1.10-K Primary:

- permeation
- degradation
- penetration
- heat transfer

Secondary:

- durability
- flexibility
- temperature effects
- ease of decontamination
- compatibility with other personal protective equipment
- duration of use

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EXERCISE 1.10-L When is personal protective equipment a necessary companion to other hazard control measures?

ANSWER 1.10-L When employees are or could be exposed to a hazardous substance concentration that is above the permissible exposure level with other controls in use.

EXERCISE 1.10-M Define absorption, adsorption, and filtration in the context of respiratory protection.

ANSWER 1.10-M (Any reasonable paraphrase of the following.)

Absorption - the process of one substance dissolving or reacting chemically with another to remove it from the atmosphere. Air-purifying respirators use absorbents such as paper fibers or chemical cartridges to remove selective chemical gases or vapors from the air.

Adsorption - the process of one substance adhering (through adhesion) with another to remove it from the atmosphere. Air-purifying respirators use adsorbents such as activated charcoal to remove selective chemical gases or vapors from the air.

Filtration - the process of trapping or screening particulates on or in a material in order to remove them from the air. Mechanical filter respirators use paper or metal filters to remove selective chemical particulate from the air.

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EXERCISE 1.10-N Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* and 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*, match appropriate regulation (third column) and its source (fourth column) with the type of personal protective equipment (first column).

ANSWER 1.10-N

| Matching PPE Type with Regulation and Source | | | |
|--|---------|---|---|
| Type of Protection | Answers | Regulation | Source |
| General | 4.c | 1. 29 CFR 1910.135 2. 29 CFR 1910.95 3. 29 CFR 1910.134 4. 29 CFR 1910.132 5. 29 CFR 1910.136 6. 29 CFR 1910.133 | a. 41 CFR 50-204.10 b. ANSI Z89.1 c. 41 CFR 50-204.7 d. ANSI Z87.1 e. ANSI Z41.1 f. ANSI Z88.2 |
| Eye and Face | 6.d | | |
| Noise Exposure | 2.a | | |
| Respiratory | 3.f | | |
| Head | 1.b | | |
| Foot | 5.e | | |